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THE COLOUR-FORMS OF THE CHRISTMAS SPIDER *GASTERACANTHA MINAX* IN SOUTH-WESTERN AUSTRALIA

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ABSTRACT

In Western Australia, particularly in the south-west, *Gasteracantha minax* populations have been found to contain adult females of four colour-forms. Within certain populations of the common patterned colour-form, there are some specimens with dark legs, some with patterning but without dark pigment and some lacking any patterning whatsoever (that is, entirely black).

Each colour-form is described, its distribution around the south-west and the proportions that they occur within different populations are discussed.

INTRODUCTION

Due to their bright colours and unusual body shapes, *Gasteracantha* species are amongst the most spectacular of all spiders. Several *Gasteracantha* species have been reported from Australia (Rainbow 1911), but the most widespread and best-known is G. *minax* Thorell, which has been reported from all Australian states and territories, including Tasmania (Mascord 1980). These spiders are diurnal and construct relatively large, vertical orb webs. Individuals build their own orb web and often they occur in dense aggregations in which they share foundation threads.

In 1871 Koch described several different species of *Gasteracantha*. However, Hogg (1900, 1914) considered Koch's species of G. *astrigera* and G. *lugubris* to be colour-forms of G. *minax*.

This paper reports on colour pattern variation observed in G. *minax* females in south-western Australia. Males were excluded from the study because they are difficult to detect in the field, due to their small size (3mm) and shorter life span.

Juveniles are not included because they are also very small and initially they build small orb-webs close to the ground, the combination of these two factors makes it extremely difficult to observe these stages in natural situations.

MATERIALS AND METHODS

Most of the data presented in this paper were taken from specimens observed in the field from December 1983 to March 1984 and June to December 1984. Representatives of major populations were preserved in

75% ethanol and are lodged in the Western Australian Museum. Additional information was taken from specimens preserved in the Western Australian Museum, and subsequent observations have also been included.

Data were gathered for a total of 19 sites distributed throughout the south-west of Western Australia. These sites were separated into coastal (less than 40km from the sea) and inland (greater than 40km from the sea). Not all these sites were included in the present analysis mainly because of lack of numbers of observations. The sites used are listed in Table 1.

Table 1. Sample sites and number of observations of spiders in each colour-form.

Site	Number of observations		
	Semi-melanic A	Semi-melanic B	Melanic
Valley of the Giants	385	0	19
Sabina River	201	9	1
Elleker	363	0	28
Nelson Rd, Shannon	40	0	24
North Walpole	30	0	20
Northcliffe-Pemberton	33	0	21
South Kumminin	137	0	0
North Treeton	47	0	0
Wooroloo	67	0	0
Bridgetown	61	0	0

Sites at Sabina River, Elleker, Valley of the Giants and South Kumminin were visited regularly in the initial study of 1983/1984. Observations were made for each distinct aggregation of spiders at each site or pooled for those cases where merging of aggregations occurred. Observations of the spiders were made *in situ*.

Colour-forms

Four colour-forms of female G. *minax* were observed in south-western Australia (see Table 2):

Table 2. Summary of the major differences between the colour-forms of *Gasteracantha minax*.

Colour-form	Dorsal abdomen	Legs
Semi-melanic type A	black & white	orange with black stripes
Semi-melanic type B	black & white	greenish black
Non-melanic	red & white	orangey brown
Melanic	black	black

1. Semi-melanic type A (Figure 1A, B). Cephalothorax and mouth-parts black. Abdomen dorsally shiny with large patches of white on a black background in a characteristic pattern (see Figure 1A). This pattern is not completely symmetrical. The white patches appear to be on raised areas and do not enter the depressions which contain sigillae. These markings become yellow as they spread under the spines towards the ventral surface.

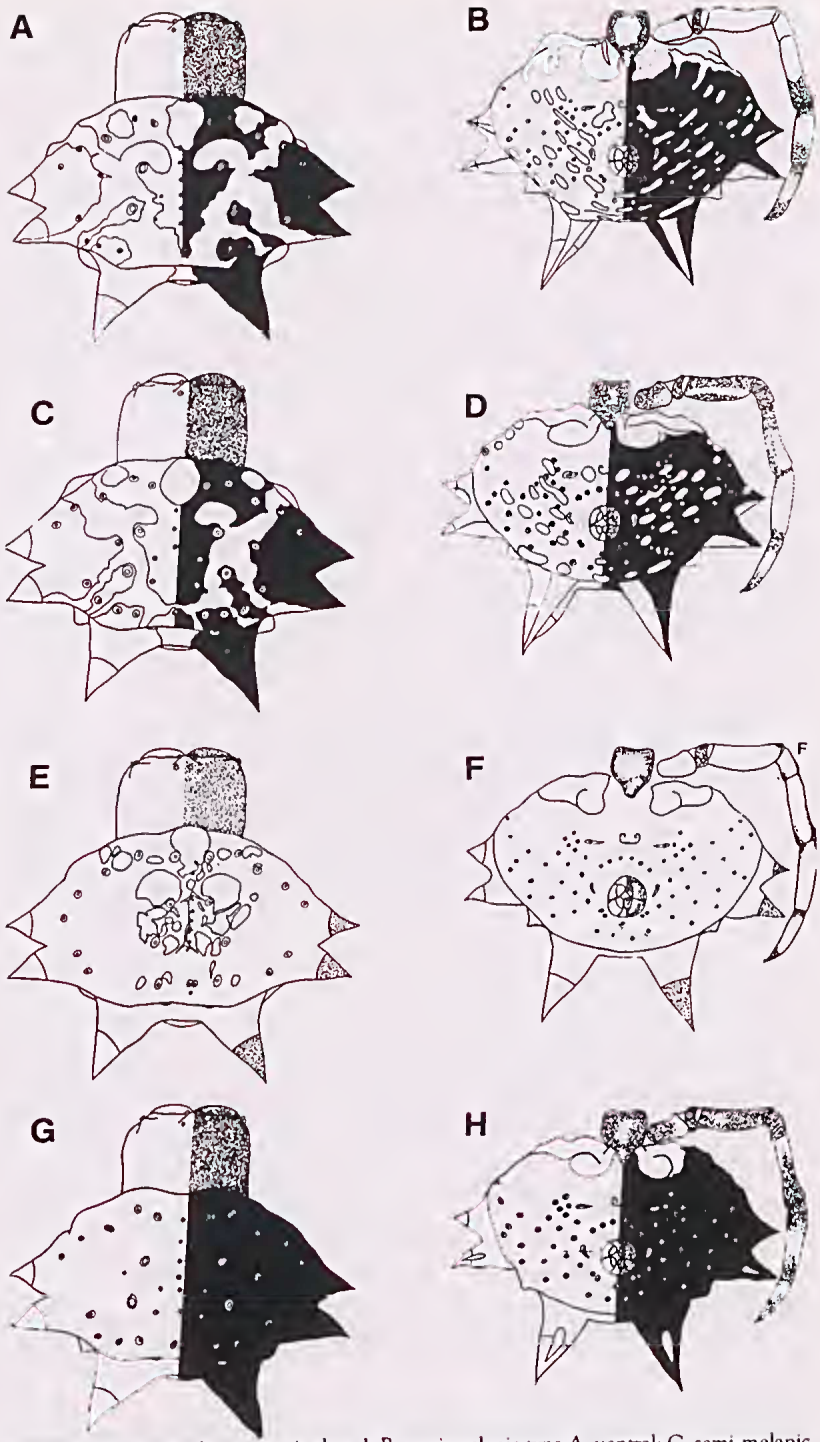

Figure 1. A, semi-melanic type A, dorsal; B, semi-melanic type A, ventral; C, semi-melanic type B, dorsal; D, semi-melanic type B, ventral; E, non-melanic, dorsal; F, non-melanic, ventral; G, melanic, dorsal; H, melanic, ventral.

The abdomen ventrally has concentric rows of raised ridges which have golden-yellow raised elongate spots against a black background. These spots may merge into thick lines. They are not necessarily symmetrically arranged. The depression between the ridges is black and contains numerous symmetrically disposed sigillae. The spinnerets are within a black circular area and are also black. The area anterior and posterior to the epigynum is black. Two large golden-yellow markings are found on either side and posterior to the epigynum. On the ventral side of the two large posterior spines there is a stripe of orange (which appears golden-yellow in ethanol-preserved specimens) up to the apex of each spine (Figure 1B).

All legs have wide black annulations at the joints of the tibia/metatarsus and metatarsus/tarsus. The coxa and trochanter of all legs is black, and most of the patella are black. The remainder of each leg is orange (Figure 1B).

2. Semi-melanic type B (Figure 1C, D). The colour patterns of this colour-form are the same as those of the semi-melanic type A except in the coloration of the legs.

Semi-melanic type B colour-form lacks orange markings on the legs. All legs are black with faintly lighter areas in similar positions to the orange stripes of type A (Figure 1D).

3. Non-melanic (Figure 1E, F). Live specimens of this colour-form of *G. minax* have a yellowish-brown cephalothorax and dark-brown mouth-parts. The abdomen dorsally is shiny with patches of white and pale orange to yellowish on a dark orange background in a characteristic pattern similar to that seen in the semi-melanic forms (Figure 1E). This pattern is not as distinct as in the semi-melanics, in particular it is more diffuse towards the centre appearing to break down to yellow patches along a dark brown line running antero-posteriorly between the four main dorsal sigillae (Figure 1E).

The abdomen ventrally has golden-yellow raised spots on raised ridges similar to those of the semi-melanics, but these spots are not as numerous and mainly surround the area around the spinnerets. The spinnerets themselves are dark brown to black. Dark orange sclerotised areas are evident anterior to the epigynum and surrounding it. The tips of the spines are darker orange than the background colour of the abdomen (Figure 1F).

The sternum has a large anterior golden-yellow centre which extends posteriorly as a narrow golden-yellow mark. This mark has a narrow border of dark brown (Figure 1F).

The entire legs of live specimens appear yellowish-green, and lack the black annulations, although there are some narrow dark brown sclerotised areas at the joints (Figure 1F).

An important feature of non-melanic females is that upon contact with 75% ethanol the abdomen loses the background orange coloration and becomes a pearl grey colour due to an underlying layer of whitish deposit no

longer being masked. In its thickest areas this deposit is evident as the basic white-yellow patterning observed on the dorsal abdomen in the live specimen. The outer test becomes translucent with the sigillae, epigynal area, spine tips and other sclerotised areas remaining orange to dark orange in colour. Dorsally, the less dense areas of the whitish deposit consist of tiny irregularly shaped spots which surround the sigillae with clear channels joining the sigillae thus creating a patchwork effect. The whitish deposit does not extend into the spines.

4. Melanic (Figure 1G, H). The melanic form of G. *minax* has a black cephalothorax and mouth-parts. The abdomen dorsally is shiny and entirely black. The sigillae are identical to those of other forms (Figure 1G).

Ventrally the abdomen has concentric raised ridges and depressions between which are symmetrically arranged sigillae. This entire area is black including the spinnerets and around the epigynum. In some specimens, on the ventral side of the two posterior spines there is a golden-yellow stripe from the middle of the spine to just before the apex (Figure 1H), in other specimens the ventral surface of all spines lacks any yellow markings. Some specimens also have a yellow stripe on the ventral surface of both lateral spines or only the posterior lateral spines. These may be less distinct in dried specimens or those preserved in ethanol for some time.

The sternum of melanics may have one or two golden-yellow marks. The larger anterior mark is smaller than in the semi-melanic type A and in the non-melanic forms. The smaller posterior sternal mark of the melanic forms, when present, is barely visible (Figure 1H).

All legs of live specimens appear entirely black. However, preserved specimens show patches of greenish-yellow on portions of the coxa, femur, tibia, metatarsus and tarsus (Figure 1H).

The major differences between these colour-forms are summarised in Table 2.

Distribution

The known distribution of G. *minax* in Western Australia, along with the distribution of the known colour-forms, are shown in Figures 2, 3.

Semi-melanic type A is the most widespread of the colour-forms, and occurs over all of the distribution of G. *minax*. Semi-melanic type B is restricted to a single population along the Sabina River.

Non-melanic G. *minax* are widespread but rare throughout the study region. Specimens have been collected from Floreat Park, Kamballup, Miling, Kondinin, Ravensthorpe, Burnabbie and East Wallabi Island (Houtmans Abrolhos), and appear to be absent from the wetter areas of south-western Australia.

Melanics are apparently restricted to the high-rainfall coastal or near coastal populations of G. *minax* (e.g. Valley of the Giants, Sabina River, Elleker, Walpole, Shannon). They have been found up to 40 km inland (near Shannon and near Wheatley).

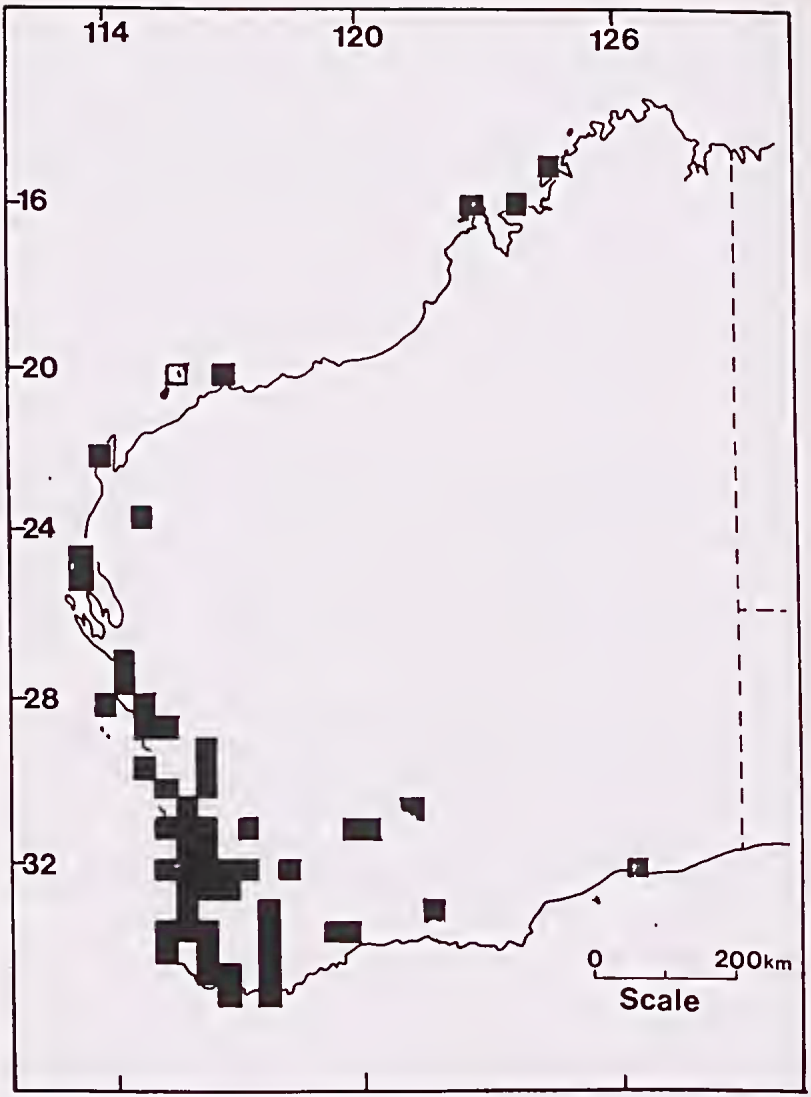

Figure 2. Known distribution (based on W.A. Museum collection) of *Gasteracantha minax* Thorell in Western Australia (open square indicates the Montebello Islands, a literature record).

Montebello Islands

In 1914 Hogg listed three varieties of G. *minax* from the Montebello Islands (see literature reference in Figure 2). These were G. *minax* var. *astrigera*, G. *minax* var. *lugubris* and G. *minax* var. *hermitis*. These varieties were based on variations in colour. Hogg described *hermitis* as a new variety and it possessed an "abdomen pearl-grey above, legs, cephalothorax, and sternum bright orange", characteristics in common with alcohol-preserved specimens of non-melanic G. *minax*. The other two varieties, *astrigera* and *lugubris*, had been originally described as separate species by Koch (1871), however, Hogg (1900) considered that the occurence of these varieties

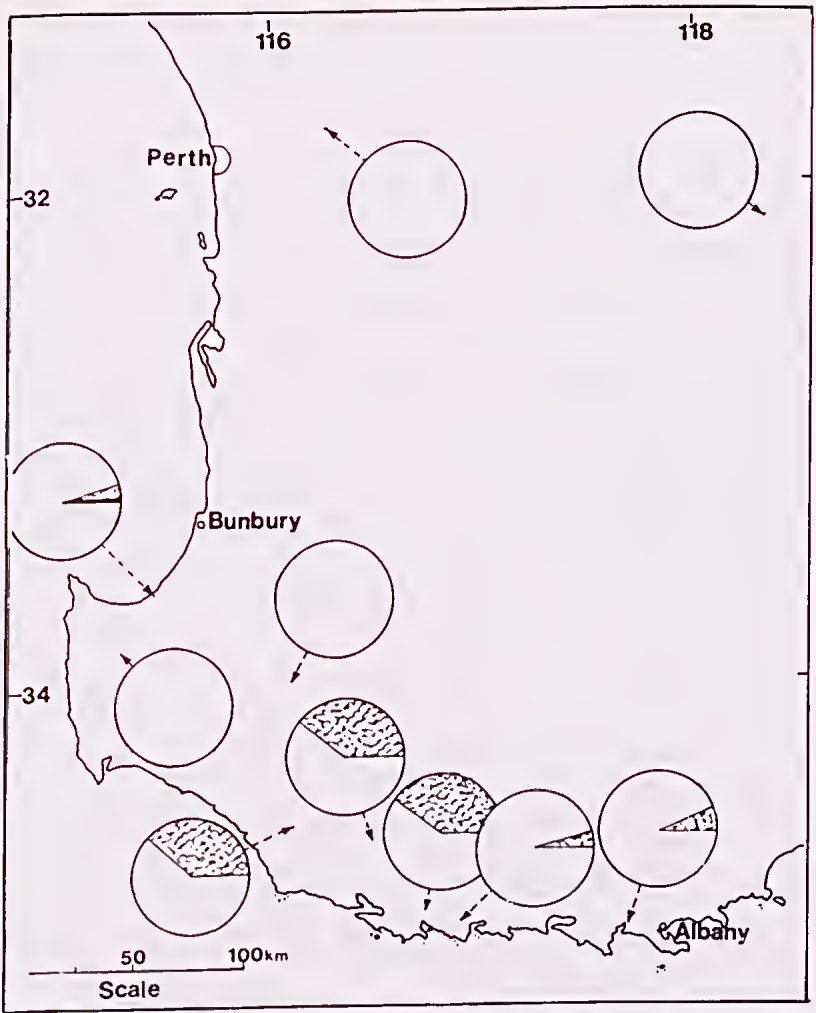

Figure 3. Distribution and proportions of the colour-forms of certain populations of *Gasteracantha minax* in south-western Australia. Within large circles, white is proportion of semi-melanics type A, black is semi-melanics type B, and shaded is proportion of melanics.

mixed in with populations of G. *minax* and the continuous variation in spine dimensions as well as lack of epyginal differences meant that these are varieties of G. *minax*.

In the present paper it was not possible to match up var. *astrigera* and var. *lugubris* as the original descriptions were difficult to interpret and until the original types have been viewed it is impossible to solve this problem here.

DISCUSSION

Melanism has not been widely reported amongst spiders. Mascord (1966, 1980) reports melanic forms in *Stephanopis altifrons* Cambridge (Thomisidae), *Tamopsis fickerti* (L. Koch) (Hersiliidae), *Araneus rabiosula*

(Keyserling), *Eriophora transmarina* (Keyserling), *Gasteracantha minax* Thorell and G. *sacerdotalis* L. Koch (Araneidae). More recently, Gunnarsson (1985, 1987) has reported melanism in *Pityohyphantes phrygianus* (C.L. Koch) (Linyphiidae).

The maintenance of colour-forms in G. *minax* may be related to predator avoidance or thermo-regulation. Robinson and Robinson (1978) suggest that in *Gasteracantha* species the glossy "enamel-like" colour patterns of white and yellow have multiple functions. The patterning may operate to form anti-predator obliterative patterns whilst also functioning in heat reflection. The strong sharp spines probably also play a role as anti-predator devices.

The presence of melanics in the populations of G. *minax* of the wetter regions of the south-west could be related to thermo-regulation strategies. According to Robinson and Robinson (1978) black-painted spiders heat more rapidly and to a higher level as compared with the normal coloration. Also, Gunnarsson (1987) found that melanic forms of *Pityohyphantes phrygianus* seem to be able to move more frequently at low (winter) temperatures than non-melanics. This advantage is probably counterbalanced by increased visibility to predators.

Alternatively, the total absence of G. *minax* melanics in the drier, hotter inland areas may be due to the white patterning of the semi-melanics acting as an aid to maintenance of a safe body temperature.

It appears that the amount of melanism varies within populations of G. *minax* as evidenced by the variable amounts of colour on the spines of some melanics as well as the existence of semi-melanics with variable amounts of colour on the legs, that is, the type A and type B. At the extreme end of this continuum would be found the non-melanic colour-form. This colour-form seems to be rare and possibly has a high mortality rate. The orangy-red colour that live specimens exhibit is probably due to lack of subhypodermal "pigment" cells which would normally mask the colour of the internal fluid of the spiders (see Holl 1987). This colour-form could be compared to an "albino" form.
Little is known concerning the mechanisms that govern colour patterns in spiders, particularly in the Araneidae.

Thus, aspects concerning the genetic basis for these colour patterns in G. *minax*, as well as discerning the possible environmental factors that lead to the retention of these polymorphisms within certain populations require future research. Also, further study is necessary in order to decide whether the different colour-forms are present within the egg or develop following hatching. It appears that, at least in the semi-melanics and melanics, all newly hatched spiderlings are patterned black and white, and melanics lose this as they mature (unpublished data).

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OCCURRENCE OF THE WHITE-WINGED FAIRY-WREN, *MALURUS LEUCONOTUS*, AT MAYLANDS, WESTERN AUSTRALIA

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INTRODUCTION

Storr and Johnstone (1988) describe the occurrence of the White-winged Fairy-wren, *Malurus leuconotus*, at Maylands as being casual, but my observations on two groups there indicate that it was resident. In view of the subsequent destruction of its habitat it is worthwhile recording my observations.

THE AREA

The western half of the Maylands Peninsula, where the two groups occurred, was mudflat. The original vegetation appears to have been sedge,